



Aviation Weather Information

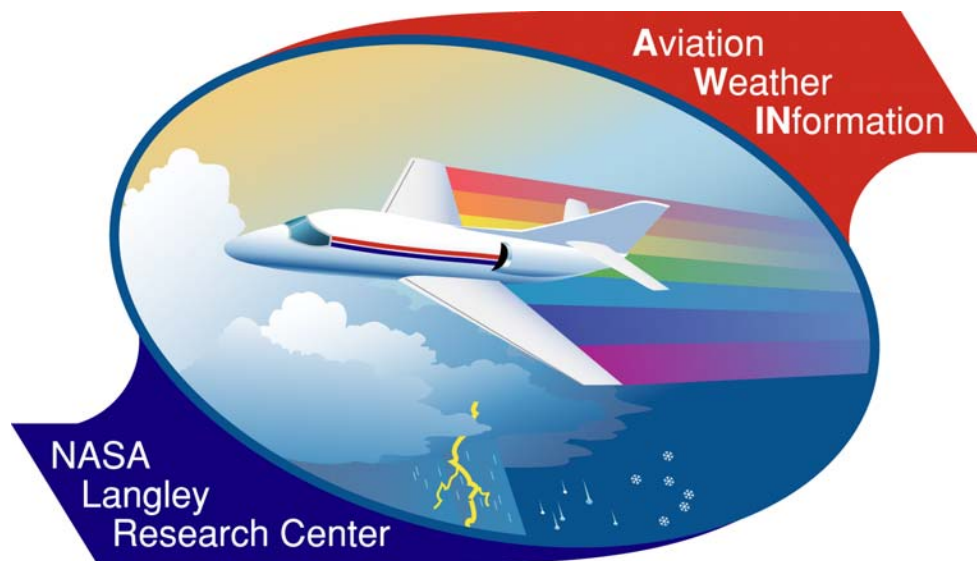
TAMDAR Sensor Development

Weather Accident Prevention Project Review

MIT Lincoln Labs

November 20, 2002

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Outline



Aviation Weather Information

- Measurement Objectives
- Sensor Design
- Current Status
- Planned Activities
- Summary

Measured Parameters



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Parameter	Range	Accuracy	Resolution	Latency
Pressure [†]	10 -101 Kp	5 millibars	±0.05 millibars	
Temperature	-55 to +55°C	±1°C	±0.1°C	
Humidity	0 to 100%RH	±5% (Below Mach .4) ±10% (Mach .4 - .6)	±1%	6 seconds
Magnetic Heading [‡]	0-360°	±5°		
Ice Detection		Less than 0.030 inch		

[†]Accuracy specified for angles of attack less than 10°.

[‡]For pitch and roll less than 30°

Aircraft Altitudes 0 to 50,000 feet



Derived Parameters

Parameter	Range	Accuracy	Resolution
Pressure Altitude	0 – 10,000 ft.	±150 feet [†]	±10 feet
Pressure Altitude	10,000 – 25,000 ft.	±200 feet [†]	±10 feet
Pressure Altitude	25,000 – 50,000 ft.	±250 feet [†]	±10 feet
Indicated Airspeed	70-270 knots	±3 knots [†]	
True Airspeed	70-450 knots	±4 knots [†]	
Turbulence (eddy dissipation rate-- $\epsilon^{1/3}$) [‡]	0-20 $\text{cm}^{2/3} \text{sec}^{-1}$	N/A	
Winds Aloft*		± 4 knots ±5°	
Ice Accretion Rate	0 to 0.25 inches/minute	N/A	

[†]Accuracy specified for angles of attack less than 10°.

[‡]Calculation of eddy dissipation in accordance with McCready Atmospheric Turbulence Scale.

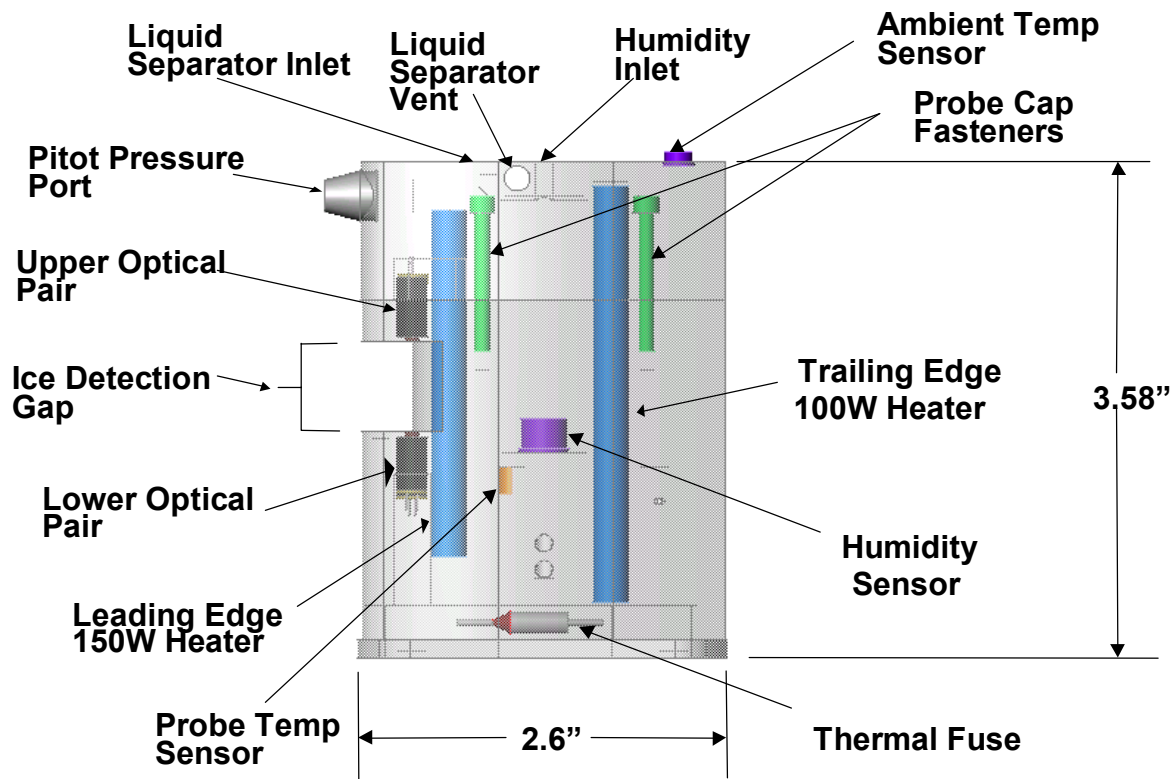
*Winds aloft calculation will require use of GPS and magnetic heading.

Aircraft Altitudes 0 to 50,000 feet.



TAMDAR Sensor Version B

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Glenn Research Center Twin Otter



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Right wing installation near cloud physics instrumentation



UND Cessna Citation-II

FRONT VIEW



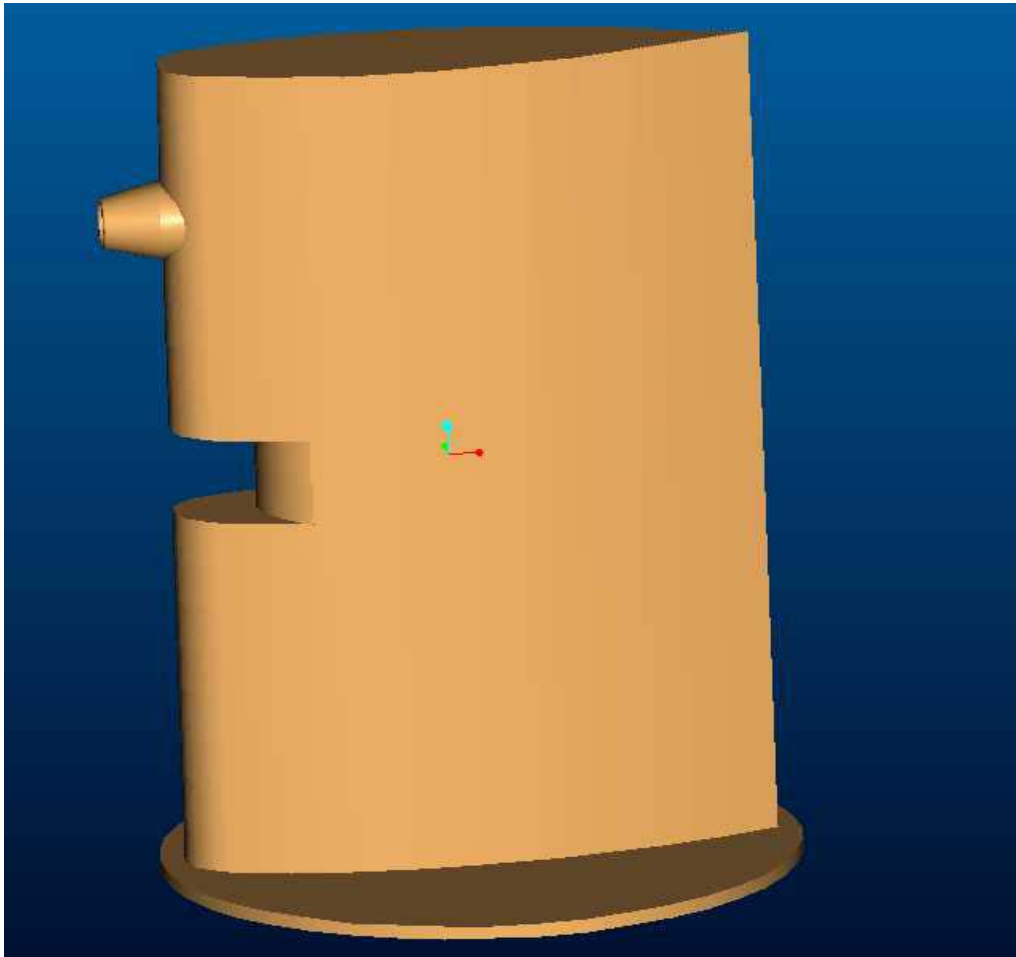
REAR VIEW



CFD Analysis



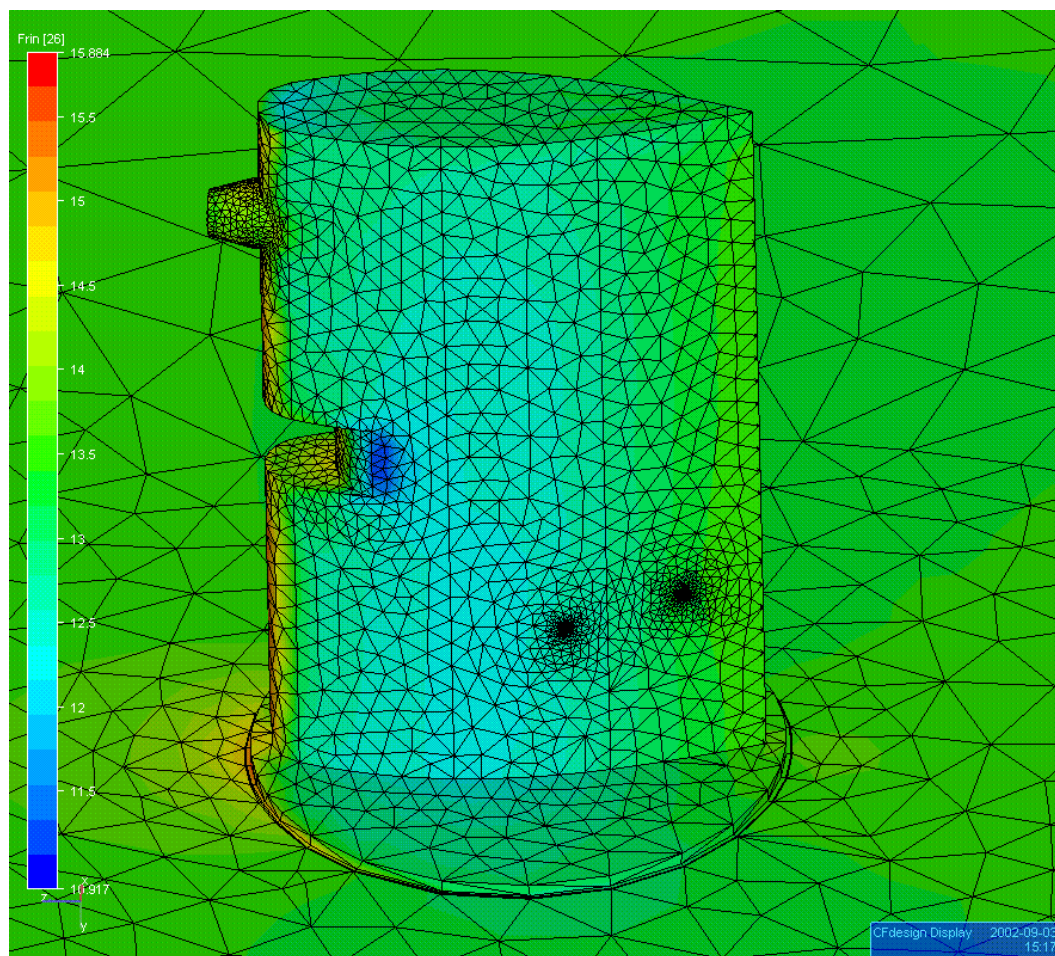
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Computational
Fluid Dynamics
modeling
conducted on probe
to...



CFD Analysis

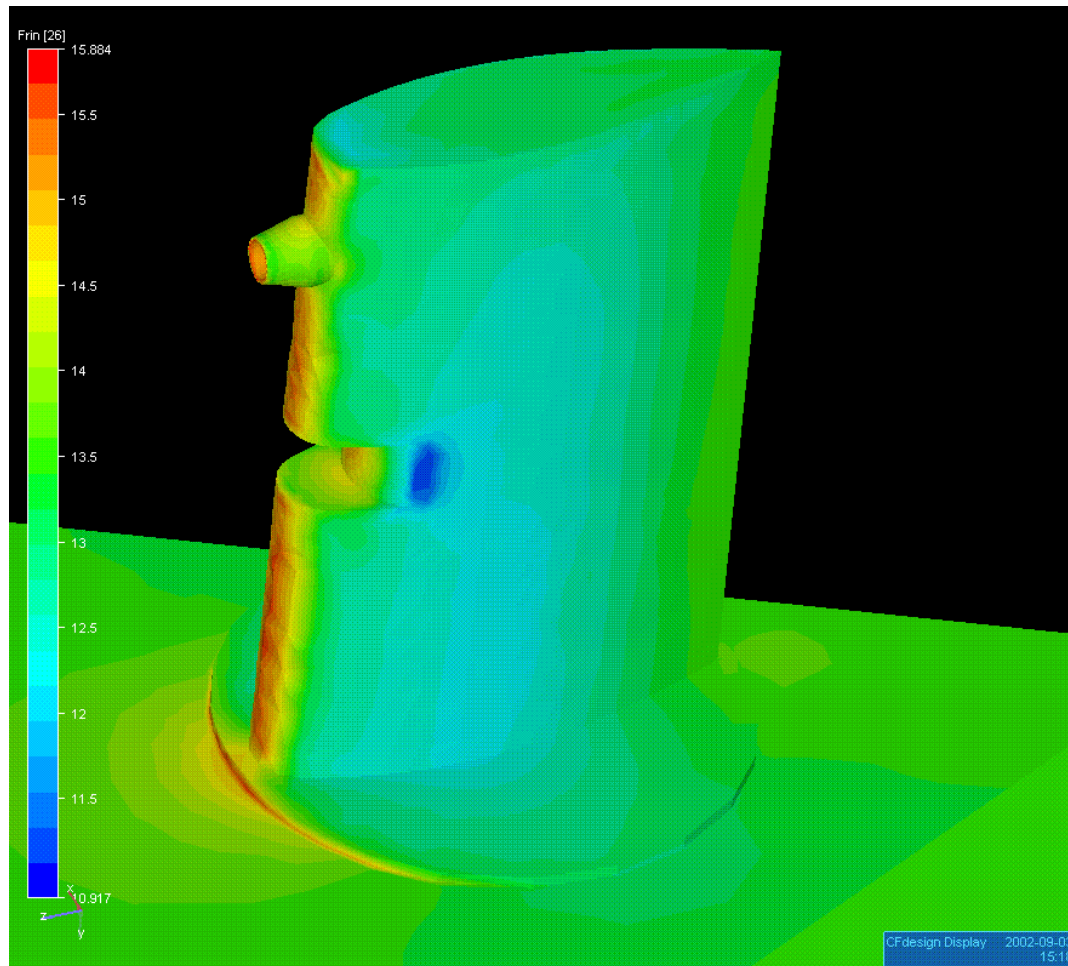


determine optimum
location for static
pressure port,

CFD Analysis



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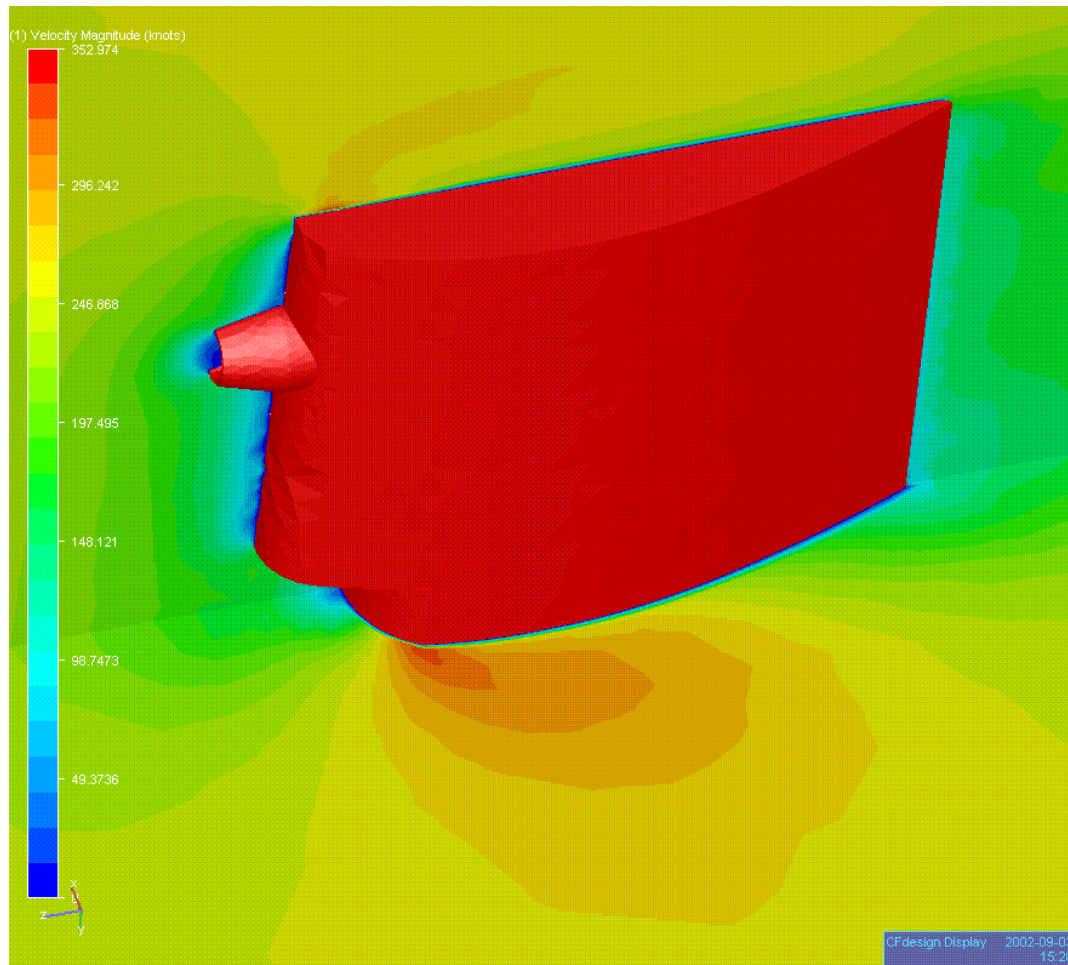


determine angle of
attack and side slip
effects, and

CFD Analysis



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determine high speed effects (for application on regional jets).

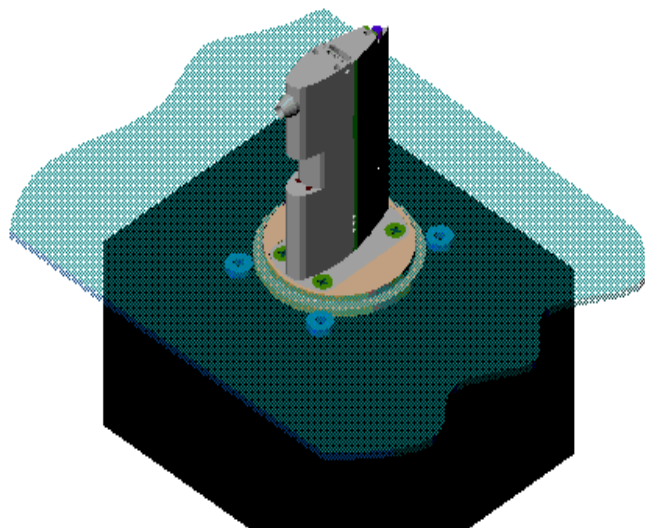


TAMDAR Sensor Version C

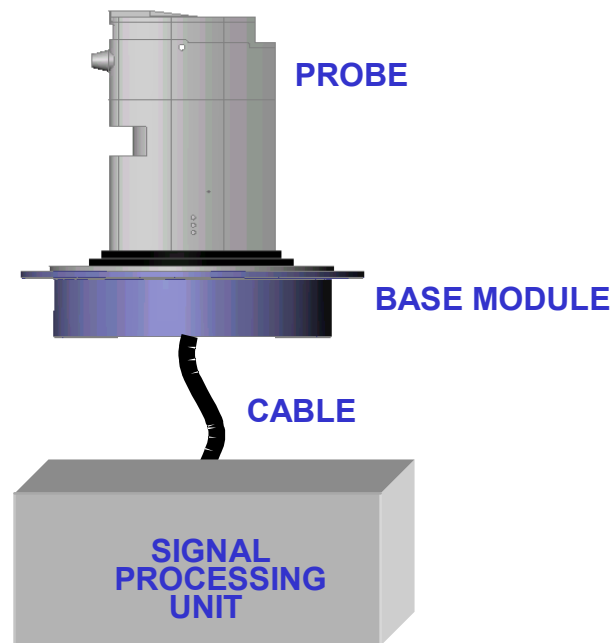
- Under development
 - For Single-engine A/C, wing mount, use A/C heading and static pressure
 - For Multi-engine, nose mount, independent of A/C
- Dedicated flight tests planned on several aircraft 1/03 – 6/03
- This version to be certified for Operational Evaluation



TAMDAR

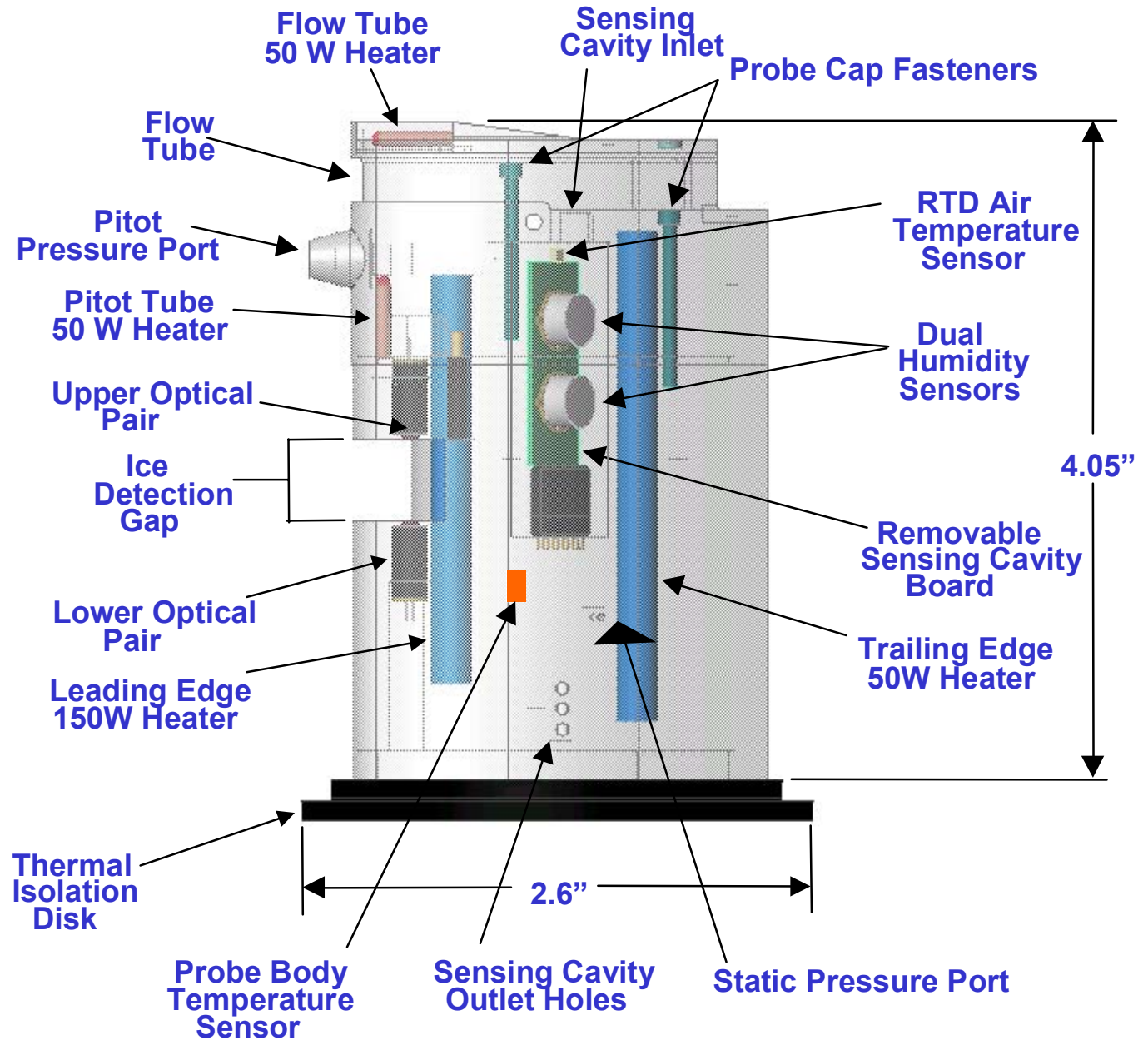


Version B: Electronics package mounted at probe base



Version C: Critical electronics mounted in base module plus a remotely located chassis.

**Preliminary
TAMDAR
Version C**





Risk Mitigation: Humidity

- TAMDAR Sensor (Version B) currently using Honeywell HHH-series capacitive sensor
- Hygrometrix MEMS-based strain gauge cellulose hygrometer (Lot 2 & 3) testing completed
- Evaluation of Hygrometrix (Lot 4) in progress (NASA)
- TAMDAR Version C to incorporate two interfaces for two hygrometers (internal)
- If Hygrometrix prove ineffective, then a new self-cleaning, Peltier stage, chilled mirror hygrometer will be developed for future use.



Flight Testing

- UND Cessna Citation II (8 months)
- NASA GRC Twin Otter (2 months)
- ODS Beechcraft Bonanza (11 months)
- LaRC C-206H and King Air
- NOAA OMAO P3 “Hurricane Hunter”
- Navy Research Lab Twin Otter (THORPEX)
- French Met Service Merlin or Cessna
- Canadian Met Service (First-Air B727 et. al.)
- FAA Safe Flight 21
- FAA Capstone (10 GA aircraft)

NASA LaRC Flight Tests



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- Shakedown, calibration, and verification flights planned
- Flights-of-Opportunity for longer-term testing (at least one per week for 6-12 months)

Aircraft Meteorological Data Reporting



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- TAMDAR presented to World Meteorological Organization AMDAR Panel during their last annual meeting
- Great interest in TAMDAR from other countries to conduct flight tests
- Meteorological Service of Canada and regional airline partner First Air to purchase 16 sensors from ODS
- Meteo France to purchase one sensor



TAMDAR Schedule

- 10/02 – FMEA initiated on Version C
- 11/02 – FAA Safe Flight 21 negotiation
- 11/02 – TAMDAR FDR
- 12/02 – FAA Capstone negotiation
- 01/03 – Version C probe available
- 01/03 – Initiate ground testing for certification
- 02/03 – TAMDAR on NASA 206H
- 03/03 – THORPEX (TAMDAR on NRL Twin Otter)
- 03/03 – TAMDAR on NOAA P3
- 04/03 – TAMDAR on UND Citation
- 09/03 – TAMDAR Certification
- 10/03 – FAA Capstone flights
- 10/03 – Initiate Operational Evaluation

Operational Evaluation



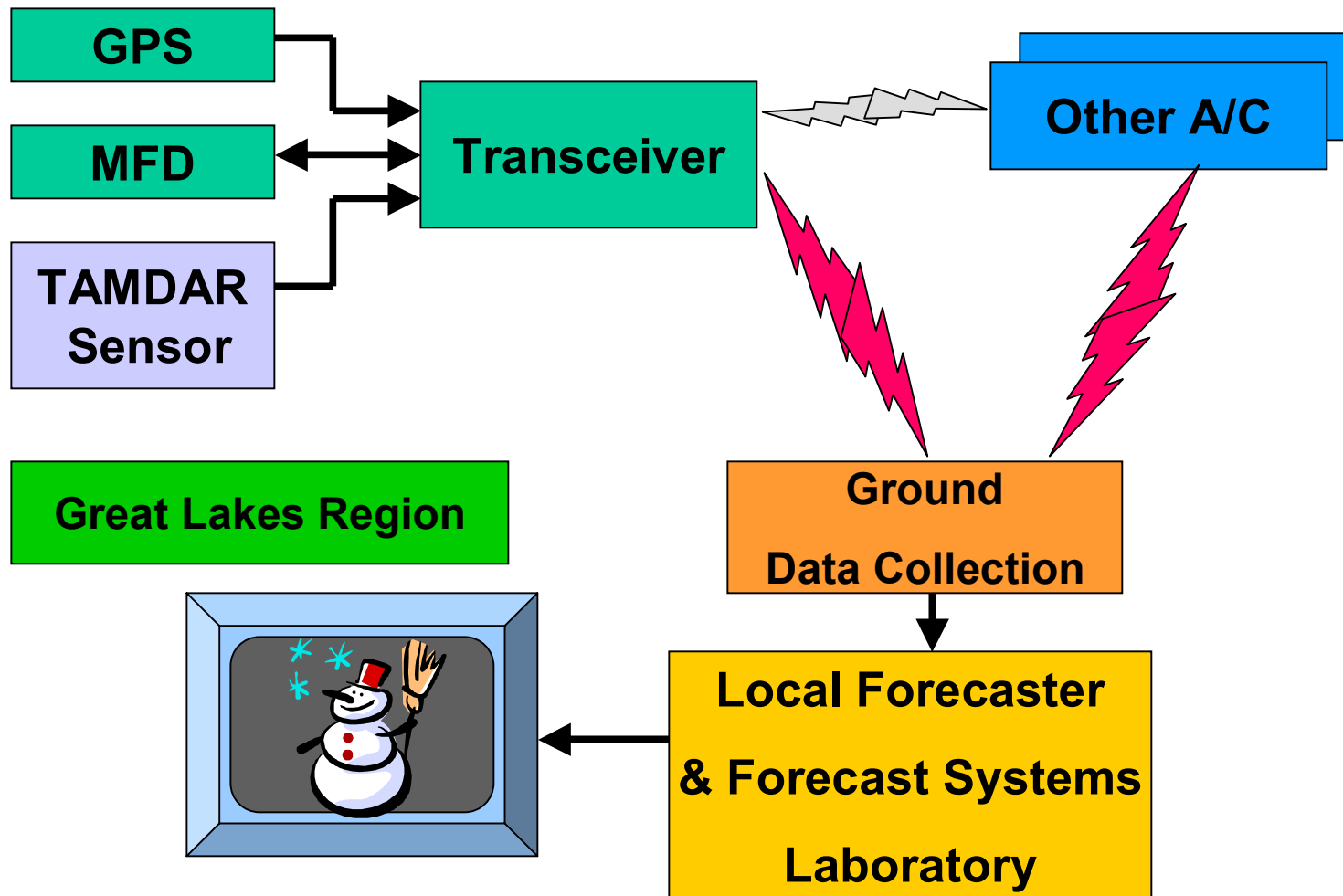
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- Version 3 to be certified for: Saab 340, Raytheon 1900, Bombardier Dash 8, Aerospatiale ATR72, or Dornier 328 depending on chosen regional airline.
- Negotiations to commence with airlines flying turbo-prop aircraft in Great Lakes region: Mesaba Airlines, Chatauqua Airlines, and Air Wisconsin
- Local Weather Forecaster Richard Mamrosh to use Great Lakes region TAMDAR data during Operational Evaluation



Operational Evaluation Concept

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Summary



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- TAMDAR Sensor Development
- Flight Testing
- Risk Mitigation
- Standardization Efforts
- Certification
- Great Lakes Operational Evaluation in 2004